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PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The eighth annual meeting of the Foundrymen's Association was held at the Manufacturers' Club in Philadelphia on Wednesday, November 1, the president, P. D. Wanner, occupying the chair.

The Executive Committee reported as follows: "This is the eighth annual meeting of the association. The organization was formed October 20, 1891, at the Manufacturers' Club in this city. Under date July 25 of that year a circular letter was sent out calling the foundrymen of this city and vicinity together to form an association, the object of which should be to improve the condition of the foundry business, a business which at that time was not in a very prosperous shape, there seeming to be more than a sufficient number of foundries to supply the castings required in this market. In consequence of the existing state of affairs foundries, in order to keep their shops going, were quoting very low figures. Some of the foundries were unreasonable enough to take a large percentage of their work at prices below cost. To a great extent this course was due to ignorance of founders as to the proper way to get at the cost of castings. They appeared to be under the impression that it was necessary to quote lower figures than their neighbors in

order to get business. The movement toward organization was well supported and the meeting well attended. The situation was talked over and a permanent organization formed. An effort was made to establish a schedule of prices for castings and for labor, but it was subsequently found that such a proceeding was impossible and unadvisable, and the matter was dropped. The object of the association was a wide one, being to take up all matters of interest to the foundry trade and to publish discussions on the same. It is on the line laid down that the association is working to-day.

"Before the formation of the association there had been several attempts made in this city to get the foundrymen together, but none had succeeded. To-day we find foundrymen's associations besides our own at Boston, Pittsburg, Buffalo, Chicago, Milwaukee, St. Louis, Dallas (Texas) and Montreal, Canada. In addition there has been formed the American Foundrymen's Association, an organization which meets once a year in different cities, and which has become very popular under the guidance of John A. Penton. Then there is the National Founders' Association, commonly termed the "defense" association, and of which Mr. Penton is also secretary. The latter association has grown to much importance and could be described as one providing insurance against strikes. It already has a large capital and has settled a number of troubles existing between the owners of foundries and their molders to the entire satisfaction of all concerned.

Another subject discussed was "The Use of the Sand Blast Compared with the Cleaning Brush." Opinions on this subject were pretty well divided in favor of both methods of cleaning castings. About the only disadvantage said to attend the use of the sand blast was that it did its work too well and exposed little imperfections on the face of castings which, when a cleaning brush was used, were not disclosed.

The use of exhaust rumblers as a method of cleaning was advocated by some of the speakers in the discussion, and many

places where they had been installed and were working satisfactorily were mentioned.

C. Von Gienanth of Eisenberg, Pfalz, Germany, was present at the meeting as a guest of the association. Mr. Gienanth represents a foundry establishment in Eisenberg employing a very large force of workmen and answered many questions in regard to the wages paid molders in his country, the amount of work they could do in a day and other matters.

At the meeting of the different foundrymen's associations held at the Manufacturers' Club in Philadelphia, on the evening of Thursday, November 16, there were present the following: Representing the Philadelphia Foundrymen's Association, T. I. Rankin, Howard Evans, A. C. Pessano, Wm. Hanson, E. E. Brown and J. S. Sterling; representing the Pittsburg Foundrymen's Association, J. S. McDonald; representing the American Foundrymen's Association, J. S. Seaman; representing the Chicago Foundrymen's Association, John A. Penton.

T. I. Rankin, of Philadelphia, was unanimously elected as chairman, and John A. Penton secretary.

The object of this meeting was stated to be the discussion of the ways and means of bringing about a closer relationship between the different foundrymen's associations, with a view of promoting greater unity and accomplishing greater results in the matter of securing and having prepared papers having reference to foundry topics, and the facilitating of the work of the various associations in every way possible.

It was pointed out by some of those present that it was sometimes difficult to secure papers in one association and not in another, that a paper read before one foundrymen's meeting was by virtue of existing conditions hardly appropriate for a meeting that might be held many weeks afterwards by another association, although it was quite possible that many splendid ideas might be brought out by this discussion, and that it might be well to have the different local associations hold their meetings on the same evening in all parts of the country, and then

have all the discussions of all the meetings printed in the Journal of the American Foundrymen's Association and in the different trade papers, every member to receive free of charge a copy of the Journal mentioned.

After a thorough discussion of the plan suggested, which was participated in more or less by those present, a motion was made that a committee of two should be appointed to retire and draw up some resolutions upon the sense of those present on the subject.

The chairman appointed J. A. Sterling and John A. Penton, who presented the following as a consensus of what had just taken place:

Whereas, there are in this country a number of local foundrymen's associations, and a national organization known as the American Foundrymen's Association, all organized for similar purposes, viz., the bringing together more closely of those engaged in the foundry business, encouraging by every means possible the preparation of technical and practical papers treating on foundry subjects, the disseminating of foundry knowledge, and the holding of regular meetings at stated periods when the welfare of the members may be promoted by every possible means. And

Whereas, there would seem to be lacking a unity of action in the work of these associations in the carrying out of the purposes for which they were instituted, while it is apparent that a closer affiliation between the several local associations and the American Foundrymen's Association could only work advantageously to all concerned. Therefore be it

Resolved, that it is the sense of this meeting that steps should be immediately taken by the various organizations referred to that will tend towards the facilitating of united action on the part of the different associations by the adoption of the following suggestions:

First. The holding of the meetings of all the different local associations on the same night.

Second. The preparation and publication in advance and the distribution of the papers to be read at the different meetings of the affiliated local associations, same to be read on the same evening.

Third. The publication of said papers in full in the Journal of the American Foundrymen's Association, as well as the discussions arising at the meetings at which said papers are read.

Fourth. That a committee consisting of the secretaries of the different associations have charge of the securing, preparing and publishing and distributing of said papers.

Fifth. That it is the sense of those present at this conference that if these suggestions are favorably acted upon by the different organizations that the plan suggested should go into operation on January 1, 1900.

After a more full and extended discussion of the resolutions, they were unanimously adopted, and the secretary was instructed to communicate with the secretaries of the different associations and submit to them a copy of the minutes of this meeting and the decision which had been arrived at. After some discussion the conference adjourned.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Pittsburg Foundrymen's Association was held at the headquarters, Frohsinn building, Pittsburg. Between 30 and 40 members and visitors were present. The meeting was called to order at 8:30 by the president, Dr. R. G. G. Moldenke. Mr. Sawhill was to have presented a paper on "The Use of Conveyors in the Foundry," but was prevented on account of press of business.

The principal discussion of the evening was on the matter of the conference recently held in Philadelphia, with the object of bringing out closer working relations between the different local bodies. The report of this conference prepared by Secretary John A. Penton, of the American Foundrymen's Association, was read, together with the resolutions adopted at Philadelphia. The substance of the resolutions was a recommendation that the various local associations of foundrymen meet monthly on the same evening and have the same papers for simultaneous discussion.

Quite a full discussion of this subject in all its bearings followed. While the association was quite ready to subscribe to the spirit of all resolutions, it was pointed out that its present quarters, which are very convenient, could be had only on a very limited number of nights, and that the holding of the meetings of all the local associations on the same night might be an awkward matter, if any other than Monday night should become to be chosen. The members were disposed to feel that this possible difficulty was not insurmountable, inasmuch as the holding of the meetings in the same week, though perhaps on different nights, would subserve all the desired ends. There was considerable discussion as to whether it would be desirable to accept more than one paper for a given night. Those who favored the securing of as many papers as possible for each night held that the paper presented by each local organization should be taken

as the one of first importance for that particular organization, and should first be read by its author, the discussion following. It was pointed out that the presence of the author always facilitated the discussion, so that by this means each paper would receive a good discussion by at least one of the organizations. The matter was finally left in the hands of Secretary F. H. Zimmers, it being pointed out that the secretary of the American Foundrymen's Association was ready to co-operate by correspondence with the different local bodies in order to arrive at an agreement on all these matters.

Mr. Seaman, president of the American Foundrymen's Association, said that the time approached for selecting the place for holding the next national convention and that both Chicago and Boston had given invitations. He asked that an expression of individual opinion be given in the matter. A rising vote showed that those present favored Boston, mainly for the reasons that the New England district stood in particular need of encouragement and that the West had already been favored in this direction.

Dr. Moldenke mentioned as a fit matter for discussion at some future meeting the whole subject of export business. He referred to some conversation he had just had with a visiting German founder, who was desirous of bringing his foundry up to the efficiency of American foundries. The molders in his foundry did less than a third as much work per day as was done in similar American establishments, but there seemed to be no way in which they could be spurred to do better.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

IRON AGE.

In its issue of November 9th, this journal refers to some resolutions passed by the Molders' Union at its Indianapolis convention concerning the operation of molding machines in the following strain:

"The wrong sort of credit seems to have been given to President Martin Fox of the Iron Molders' Union of North America for his recent advice to his members not to oppose the use of molding machines. In acknowledging that an error had been committed by union molders refusing to use them, and recommending that they should hereafter cheerfully work with such machines, it appears that he was not to any great extent imbued with the spirit of progress and ready to recognize that foundry methods had been improved. From developments which have since occurred in Western foundries it would appear that his purpose was to bring the operation of molding machines under the control of the union, so that their competition with hand molding could be minimized. Disputes are now awaiting settlement in which this question has acquired considerable importance. Manufacturers who have introduced molding machines in their foundries with satisfactory results as to increased output and reduced cost are certainly loath to give up these advantages. But they will practically give them up if they accept the regulations governing such machines which the unions seek to impose."

E. C. Wheeler contributes the following article to the same issue on

Physical Characteristics of Malleable Cast Iron.

The advantages and necessity for uniformity in malleable, when the same is to be used in castings subjected to the frequent and non-equal strains incident to their locations on machines, railway cars, etc., and developed under so many dissimilar circumstances, combined with varying temperatures, make the

question of physical characteristics one of great moment. Until within a few years ago the best guide, with reference to quality, has been the cold bending tests given after annealing, and if metal has proved soft and malleable under these tests the material was accepted as successful. This test is still, for a great many purposes, a most reliable one, when light castings are being considered. With heavier castings, however, when diameters are 3-4 inch and over, it has been rather difficult to produce satisfactory cold bending tests, the main stay being in such cases the appearance of fracture after cleavage break or shear; and it is with reference to the latter class of castings that physical tests are most applicable. As all heavy castings are subjected to their service requirements when cold, it will be recognized that only in rare cases have they been called upon to withstand service involving any noticeable deformity in original lines.

The successful casting is one which will withstand such service and still present the same lines as before. The material need not be so high in tensile strength to accomplish this end that malleability should be sacrificed. Malleability in heavy castings does not convey the same meaning when comparison is made with light castings. In light castings it is a soft, pliable and contortionable condition. In heavier castings it is the ability to receive shocks and blows without breaking or bending, and this in no degree means excessive tensile strength or excuses shortness and hardness. The questions are often asked, What will your iron stand? What can be done with it? Will it bend back upon itself? All are quite natural questions, but when speaking of heavy work they do not exactly fit the case. Nor is the M. C. B. drop test for draw bars a satisfactory test for quality. There have been couplers known to stand a number of blows in excess of the prescribed specification, but in service the group represented by the tests has failed signally. There is certainly some patent cause for this, not easily explained. The perfection reached in open hearth steel casting is directly due to the lines drawn relative to chemical and physical limits. There are as yet no specifications for malleable touching either, although one rail-

road in the East has designated the tensile strength desired in its castings. It is a question whether malleable concerns are prepared at the present moment to guarantee their product following somewhat these lines, as there has not been that liberal usage of the laboratory and its accompanying advantages to warrant confidence in each succeeding heat poured. But it is believed that the near future will find all prepared to welcome specifications.

There will be no greater incentive possible to any concern than the knowledge that they are working to "limits." As it stands to-day, the make up of metal varies with every individual concern, and while thoroughly reliable for local usages, suffers by comparisons in the interchange of parts sometimes necessary in railroad practice. With the advent of restrictions will come the uniform shrinkage so eagerly wished for at present. A physical test for malleable iron which calls for more than 45,000 pounds does not guarantee the ideal metal for railroad work. It will possess that doubtfully beneficial strength which shows to great advantage upon reports, yet has in it an element of hardness which precludes the possibility of long service. Physical testing is just beginning to attract the attention due its importance, and perhaps the delay in this matter has been caused by the fact that malleable, like steel in the past, has now passed through all of its experimental phases. The idea of physical specifications is very new, but it will prove a most excellent ground gainer to the careful manufacturer, whose pride in his output amounts to a question of honor. With the adoption of physical standards will arise the necessity of employing chemists in all works, for the effects of the metalloids upon physical characteristics are well marked. It cannot but prove to be a source of great satisfaction to careful producers, for they will be guarded with a bulwark of safety. The malleable casting of to-day is one of the greatest offerings in the whole iron industry, representing as it does many long years of patience in perfecting it, and yet the real work is only begun. There are many concerns making good malleable, and not a few better than before. The reason

seems quite obvious. A few years ago chemistry was adopted into the malleable art and was stamped a great thing, but in some localities it was not entertained with the respect due its worth. Questioned and suspected at all points, it was finally discontinued, with the result that some firms have gained nothing whatever from the experience, while others are enjoying the undeniable benefits procured by judicious management. The future development of the malleable casting must be along the lines of chemical and physical testing.

The heat treatment of metal during melting and annealing has a very important bearing upon its developed tensile strength, elongation, etc. The generation of excessive temperature always promotes the chances of burning, and while metal may be burning the chemical aspect changes but little, while the molecular composition is receiving a shock from which it never recovers. What is burnt iron? And why does iron become susceptible of burning? These are seasonable questions upon which there has been considerable discussion and many theories advanced, yet there are many skeptics upon the subject. Iron is burnt mainly through the generation in melting furnaces of higher temperatures than those prevailing during the initial casting at blast furnaces. Superheated metal is always to be feared regarding quality. When a heat is charged in which all the metal is "low" or high silicon pig the opportunity for burning is not as great as in heat charged in which the metal is "high" or low silicon. The first mixture has an element of contained heat to balance heat of blast while melting, but the latter has no resource in this direction whatever. If these heats were charged following each other there would be, nine out of ten times, no changes possible in the method of firing, consequently no great variance in heat of furnace, and yet there should be some counteracting agency at work in the high mixture to offset excess heat of the low mixture. Superheated metal, or metal not high enough in silicon to hold fluidity, is readily discernible in ladles by the rapidity with which it sets. This metal will in the physical tests show considerable tensile strength, but a small percentage of elongation.

This latter is due to the fact that the "clinging" propensity of the molecules has been injured beyond redemption. There is no tearing of the metal in testing machines previous to the break; it "goes" all at once and there is that omnipresent heavy white edge to characterize it. The mixture high in silicon should obtain its tensile strength from its silicon-carbon content and elongation from the undisturbed state of its molecular condition. The mixture low in silicon should receive its tensile strength from the density of the molecules and its elongation and reduction of area from the low carbon content.

When the heat of blast through the melting furnace is too strong, owing to an excess volume of air being introduced, the metal after melting will start to oxidize. This metal upon reaching its crucial stage will then be in condition to burn readily, having already exhausted considerable of its reserve qualities. It will be readily seen that this condition will affect the tensile strength most naturally.

The very choicest irons thus turn out poor material, whereas if the heat had been allowed to "come up" slowly we could have anticipated the best results. A well calculated heat will (unless something unforseen occurs) invariably produce excellent results if worked slowly.

The action of the annealing ovens is also well defined in this direction. Whether the fuel used be coal, coke, gas or oil, the result will be the same if heat is brought to its highest point before the metal is ready to receive it. Burnt iron in the anneal is no uncommon feature, and, generally speaking, it is the result of carelessness. The real value of the annealing department is very often overlooked. It is often in charge of men whose compensation is low and who (to their credit must be said) do their work, as a rule, in proportion much better than their companion foremen of other departments. But here, as elsewhere, there has not been that confidence in their work which should guide them. They work by precedent and ask no questions. The theory of the anneal is sometimes a ticklish one with them. The most carefully prepared metal from melting furnaces can here be

turned into worthless castings by some slight inattention of detail. The highest point in temperature for the annealing should be registered in each foundry, and kept there by the daily and frequent usage of a thermometer constructed for that sole purpose. The uneven workings of furnaces accounts for many a batch of rejected castings. These latter conditions are more likely to occur in plants where coal and coke are used in ovens, as it is simply impossible to regulate heat under these prevailing circumstances. With oil and gas the danger is greatly removed and, barring occasional changes in pressure, the heat is uniform. Changes in the heat will at once affect the quality of iron. Steady, continued heat insures soft castings, while unequal temperatures destroy all chances for successful work, though the initial metal was of the most excellent quality.

The question as to the effect for good of charging the packing with sal ammoniac is at the present moment being agitated very generally, and it is with some hesitancy that the writer expresses himself. There are some concerns who never charge their packing, and claim as beneficial results as those using the prepared packing. They claim that there is nothing which anneals but heat. However, fact is fact!

The experiment was tried, and most successfully. One set of test pieces was taken and packed in "dead" packing and the other in "charged" packing. These bars were poured in each instance from same heats, from same ladles and in the same molds, and were packed in furnaces with the heat conditions alike for both. With packing charged in some manner the castings will be softer, having more elongation and greater reduction of area.

Unprepared or "Dead" Packing.

Number of test.	Total carbon, hard iron.	Total carbon, soft iron.	Tensile.	Elongation. 6 inches.	Per cent. elongation in 6 inches.
3812........	3.23	3.01	48,600	0.37	6.16
3831........	3.39	2.92	47,400	0.30	5
3851........	2.97	2.90	46,800	0.27	4.50
3861........	3.10	2.90	47,400	0.31	5.16

Prepared or "Live" Packing.

Number of test.	Total carbon, hard iron.	Total carbon, soft iron.	Tensile.	Elongation. 6 inches.	Per cent. elongation in 6 inches.
3812........	3.23	2.90	48,900	0.43	7.16
3831........	3.39	2.81	45,600	0.33	5.50
3851........	2.97	2.72	48,600	0.36	6
3861........	3.10	2.82	45,900	0.34	5.83

These tests show unmistakably the treatment due a physical test by proper handling of annealing department. Be not deceived. It is true that without preparation of the packing the annealing may be carried through, and the appearance of the castings for months may not vary, but they will not be soft. And in the case of prepared packing the identical same test bar gained from 1 to 1½ per cent, in elongation in all cases. The discontinuance of charging packing is an economical move with reference to handling work cheaply, but in the instance of heavy work it is costly practice in the end.

That the chemical components exert a powerful influence upon the strength of iron is an assured fact, though not as fully understood in the case of malleable as with gray iron and steel. The metalloids most injurious would be singled out by the proposed specifications and limits placed thereon. Here again will that ever prominent feature of heat conditions assert itself. The metalloids occurring mostly in pig iron may be grouped with reference to their peculiar effects upon the physical showing of tests, and thus we would have in the finished metal silicon, manganese and graphitic carbon working together for the strength, and sulphur, phosphorus and combined carbon affecting the tensile strength. With silicon and manganese in their certain and relative proportions there can be no doubt of their beneficial action toward strengthening the product, and almost, it may be said, when in excess to the point of "shortness." Very often the metal has shown in tests and finished castings a steely fracture, and almost invariably has the same been explained by the presence of too much silicon. Chemical research has also demonstrated it. When the silicon is about 0.75 in finished metal it will show higher tensile strength and less elongation, for the

reason that had the same mixture been properly worked the silicon would have been reduced, but now it resembles, after a manner, gray cast iron, with its correspondingly high silicon content. With this high silicon comes a resulting condition—namely, higher carbon in the graphitic state. There cannot be a high silicon and low carbon in material, as these two elements must act jointly in eliminating each other. The low silicon-carbon content must be maintained when calculating heats in which strength is desired. Silicon holds the carbon in certain ratios, as in the making of steels. That low total carbon is the secret of attaining reduction of area and elongation is demonstrated beyond a possible doubt. In the following tests there will be found some of these facts demonstrated—namely, with low silicon and carbon comes the reduction of area and elongation:

Number of test.	Silicon.	Total Carbon.	Tensile.	Reduction of area.	Elongation in 6 inches
219.........	0.62	2.20	47,350	3.27	5.33
227.........	0.51	2.40	48,950	3.42	6.50
228.........	0.58	2.32	45,370	4.33	5.83
231.........	0.47	2.07	42,050	4.83	7.83

Manganese in the latest practice is kept high, mainly with reference to the combining of carbon in the hard iron, with that easing off of liquid shrinkage so prevalent in the older working. In the anneal manganese stands practically unaffected by the heat generated there, and so is an element of strength all through. The reduction of area and elongation are the direct results of low carbon. It is simply a metallurgical impossibility to have the reductions, etc., with a high carbon content. With sulphur and phosphorus comes a weakening of malleable. Their action and effects are clearly drawn, both having a hardening tendency, making metal stiff. Often in malleable foundries castings containing carbon in the graphitic condition are passed through the hard iron inspection to anneal, and these castings show high tensile figures, but with small reductions. To obtain an iron which will work under the hammer while hot and without caking (this is a very trying operation) there must be this low silicon-carbon-phosphorus feature. Malleable iron with high

carbon will not bend back upon itself. The following figures are from heats in which these negative features have been prominent:

Number of test.	Per cent sulphur.	Per cent phosphorus.	Total carbon.	Tensile.	Reduction of area.	Elongation in 6 inches
220.......	0.052	0.272	2.72	49,500	1.07	3
242.......	0.061	0.197	3.01	49,000	1.23	2.33
247.......	0.047	0.216	2.42	47,620	2.02	1.83
248.......	0.058	0.172	2.67	51,000	0.82	1.50

The most destructive features of high sulphur and phosphorus are the small cracks, like incisions, over the surface of castings. In physical testing these cracks play a considerable part in the question of elongation, too small at times to be seen, yet the stretch of the metal taking place in these apertures leaves no great elongation in the metal. The combined carbon in annealed castings, which is, in most cases, very low, still has a hardening effect. Though not prominent, it still contributes. A very beneficial move was made some time since by a blast furnace management in Ohio, when they put a burden of selected ores in stack and cast the iron into iron chills. This iron was ideal for malleable, having a low silicon-carbon content, with phosphorus and sulphur in reasonable limits, and was a great step forward toward the end hoped for in coke iron. But at the time of its initial appearance it was not taken up with the favor it should have received, and was therefore not appreciated, being thought premature. A heat of this pig metal under the writer's observation developed the following remarkable results: Forty-seven thousand pounds tensile strength, 4.33 per cent. reduction of area and 8 per cent. elongation. Stiffness with malleability. It was a distinct move in the right direction toward uniformity of material.

In considering this topic we will call the heat test—i. e., the test made at the furnace to determine whether carbon is in combination—a physical one, and the endeavor will be made to demonstrate that this test, while carrying great weight as to the condition at the point of pouring the metal in the furnace, does not possess the necessary reliability and does not, strictly speaking, furnish a fair criterion of the metal. Here again is encountered

a heat condition. A furnace charged with 10 or 12 tons of metal, and taking from one-half to three-quarters of an hour to run out, according to the size of the tap hole, cannot produce metal which may be called uniform. As soon as metal has been brought up to its highest heat, carbon being in combination, the quicker it is gotten out of the furnace the better will be the ensuing product. After the highest heat point has been reached the continued blast necessary to maintain the heat in the metal to a suitable point for pouring works havoc with those chemical metalloids which affect fluidity, but, on the other hand, enhances the chance of a better iron physically by serving to reduce the carbon and silicon. Thus it will be seen at a glance how impossible it is to rival open hearth steel regarding uniformity, or even, in many cases, a well managed cupola on gray iron. In open hearth steel practice, when carbon and silicon have been reduced to a certain specified point, the "heat" is drawn in bulk and there is no further chance for a chemical or molecular change. In gray iron cupola practice new raw material is constantly coming in contact with fuel, and insuring, in a way, the continued grade of metal at point desired. In the air furnace, on account of the length of time the liquid is kept in contact with the flame incident to pouring, it of necessity affects the molecular conditions, and in the case of pouring heavy castings (and this is the class of work being considered under this heading) the last iron out is better than the first. There cannot be a doubt but this fact accounts in a measure for the variations met with in material after the anneal.

In heavy work mixtures the first metal poured from the furnace will be "softer," or higher in total carbon, consequently inclined to be of an open grain, and the last metal is denser, being lower in total carbon, etc. That there is a marked and influencing difference between extremes of heat (from the moment the metal is tapped until run out), which explains many breakages, is clearly demonstrated by tests here submitted, taken in each instance from same heat at extremes:

First Iron.

	Total carbon.	Silicon.	Tensile.	Elongation in 6 inches.
261	3.52	0.91	46,500	4.33
263	3.37	0.72	52,000	3.37
265	3.42	0.68	49,000	2.93
267	3.29	0.89	43,000	3.33

Last Iron.

	Total carbon.	Silicon.	Tensile.	Elongation in 6 inches.
261	3.23	0.62	42,700	6.16
263	3.09	0.68	46,000	5.23
265	3.27	0.62	42,000	4.27
267	3.07	0.72	42,000	3.33

In keeping this idea of desired uniformity ever before us, the question naturally arises, How can the result be otherwise, using the present reverbatory furnace? With light work mixtures the differences are not marked to any great extent. In heavier work there is a remedy, and one tending toward a possible solution of the question. It has been the writer's privilege for two years to have charge of several Siemens-Martin acid open hearth furnaces producing malleable iron, and during that period he had great opportunity to study the problem in hand, and believes that thorough uniformity is possible and necessary.

Owing to a peculiar foundry construction it was not possible for the molders to catch the metal at furnace spout, and it was not practicable to carry metal to them in "bull" ladles. Therefore the whole heat of eight tons was tapped into a previously heated ladle and conveyed by electric crane to a suitable place in the foundry for pouring. The tests at the furnace were made until just the point desired was reached and then the furnace was tapped. In less than one minute the contents were in the ladle away from any possible further chemical or molecular change. This metal was uniform! The results of this peculiar practice gave the castings thus produced a great prestige over the ordinary air furnace metal. The physical tests were most encouraging. The adoption of this style of furnace in malleable works would be a most radical change in founding, though not practical in present erections. But with the necessity of a better

and more thorough refining of coke iron this idea is brought forward as possibly an outcome of the situation. The most satisfying feature about it is that it is no experiment. Here we have at this early day a thoroughly advanced material claiming the attention of more thoughtful producers.

Some of the physical tests are remarkable and show to great advantage the points mostly desired in railroad castings:

Number of test.	Tensile.	Reduction of area.	Elongation in 6 inches.
A	52,000	6.42	7.33
B	49,000	10.12	6.50
C	48,000	11.12	7.00

The appearance of hard iron tests are forerunners of the quality of iron after annealing. Seen under the magnifying glass are many peculiar phases, all of which have directly traceable bearings upon the resultant product. In the light work mixtures the tests show a distinctly rough and disjointed condition of the particles, owing to the fibrous nature of the metal when in hard iron, and, having a high carbon content, break with the toughness of original pig metal, there being in such instances but a small loss in carbon. After annealing, this metal, which in the hard iron was so tough, is now lamentably weak, owing to this excessive high carbon.

In the tests for heavy work mixtures the microscope reveals an entirely different aspect. There is that crystalline glacial formation, converging toward the center, owing its formation to the intensity of cooling strains, and which in many cases when iron is run too "high" causes castings to crack. Then, again, is found a test, with crystals as large as in a No. 3 iron, having a black circle around its edge. This almost invariably comes from a higher percentage of sulphur which has combined carbon higher, relieving somewhat the internal strains. A test piece 1 inch in diameter will show a complete combination of the carbon, but one 2½ inches in diameter, poured at the same moment from same ladle, will show graphitic carbon in bulk. In cooling tests in hard iron, preparatory to tapping out, the test will, if the carbon is combined, crack with a distinct ring,

whereas if there was graphitic carbon present the latter would assemble in small groupings, holding the metal together and resisting the action of water. The most satisfying test in hard iron is the "wedge," giving, as it does, an early criterion of the capabilities of the heat. This test acts not only as a physical test, but also serves as a fluidity guide. When carbon is only about one-half combined with the iron, and two large tests should be poured, one of which will be cooled with water and the other allowed to cool by itself, the former will show small and regular clusters of graphitic carbon remaining, while the latter will resemble very closely a light colored gray iron, the crystal groupings being very dense. This latter condition arises entirely with the heat remaining in test for a considerable period, thereby holding that proportion of graphitic carbon remaining in suspension. In the test cooled with water the graphitic carbon, being in excess of the absorbing qualities of the iron at that particular point in heat, has been driven into the small group, as before described. These above mentioned phenomena occur mostly when the silicon content is high, particularly in light work mixtures, and show to great advantage the altering phases of carbon. Carbon is never thoroughly combined with iron until the silicon has been greatly diminished. A high percentage of silicon will hold carbon in suspension, preventing the combination so essential in heavy castings. In light work with its high silicon and carbon, metal is chilled and carbon is combined by contact with damp sand. In malleable cupola practice this is about the only method of affecting carbon, there being practically no molecular change possible in cupola while melting. A low total carbon and silicon—a certain percentage of sulphur being present—has the effect of giving test pieces their very close fracture, resembling the high state of glacial crystallization found in No. 6 or No. 7 iron. Higher carbon and silicon and lower sulphur keeps the test pieces gray for a continued period, necessitating higher heat in furnace, while at the same moment affecting the life of fire brick in no small manner. The malleable casting, when cast, is subject to both internal and external

strains, according to section. The malleable draw bar with surface chills and hard cores has been relieved of many detrimental features. But with the lighter castings and patterns of unequal diameters there is always the likelihood of cracking under casting strain. There are several safeguards against this trouble; one of the best is the usage of small quantities of aluminum in ladles.

There have been many shapes under personal observation which, when molded, presented a great question regarding best method for saving same when cast, the only resource in some cases being a cooling down in a previously heated furnace over night.

If there is to be any possibility in the future for uniformity in malleable castings there must be adopted some general method of testing, which will be broad enough to cover the inequalities of comparative workings. To sell malleable under chemical and physical classifications is, at the present moment, an impossibility. This also was the history in steel castings for many years, but with far sighted experiment the point has been reached when producers may guarantee their metal with safety. The adoption of a test bar for general use could be decided by some discussion. We believe, however, that it should be exactly 1 foot long, and when molding a chill should be placed upon either end, to thus attain the greatest shrinkage. A micrometer reading should then be made of bar before annealing and shrinkage for shop practice established. Malleable concerns making agricultural shapes, etc., cannot afford to deviate in their founding practices as castings which are supposed to fit snugly over other shapes must be made of metal in which the correct amount of shrinkage is assured. When metal is said to shrink $\frac{1}{8}$ or 3-16 inch to the foot it is understood that this is hard iron shrinkage in all cases. The metal in annealing expands, and finished product shows rarely over 1-10 inch shrinkage from original measurements, bringing it finally close to gray iron shrinkage.

To illustrate above statements the following figures will prove interesting, one set showing hard iron shrinkage and the other

set the shrinkage found after anneal, the test bar being exactly 1 foot long:

Hard.	Soft.
0.225	0.090
0.225	0.100
0.235	0.125
0.237	0.087

The above figures represent a very fair working, no freak heats being considered in figures given by writer. A very convenient form for the bar is a round section which figures about 1-3 square inch. The square bar is absolutely without one redeeming feature when considered for malleable work. The pattern should have 6 inches in the clear in center and be enlarged towards ends for the grips of the testing machines. In molding bars the gates should be cut upon the side of the bar near the ends, but not on the ends. The pattern should be well proportioned, bringing the larger end sections to meet the smaller middle section by an easy gradation, thus avoiding the shrinkage in bars which causes them to break in the grips of the machines. With the present air furnace practice test bars should be poured as near the middle of the heat as is possible. The number of each heat being molded upon the end of the test bar will, while following the physical results, also furnish a reliable guide in determining the chemical composition of any heat desired. The test bar is the surest method of following a heat's working through the process. The matter of having bars tested brings the matter down to a question of local coloring. Many concerns will argue that the physical test is not of enough importance to them to warrant purchasing a machine for their use. Physical testing is a recognized necessity with all the larger concerns producing railroad castings and these works will have their own apparatus. A very good plan for smaller works to pursue would be to make some arrangement with parties having machines for a test at least once per week.

Riehle Bros., Philadelphia, manufacture a small machine, 50,000 pounds capacity, which is ideal for malleable works. Since

the test bars are 1-3 or ½ inch diameter the capacity is far beyond any possibility in the metal. This machine, when connected with a 1 horse-power motor, is very convenient.

There is not one branch of the iron and steel industry, with the exception of malleable cast iron, which has not undergone some very radical changes in mode of production during recent years, and all have proved to be benefits physically. With the tightening of the iron market and loss in choice of buying iron, the producer finds an awkward situation to face in the maintenance of uniformity in castings. There must be a new malleable furnace projected ere long. The moment is more than ripe for its introduction, and when it does come may it combine some slagging and absorbing features with its melting hearth. The inability of the individual blast furnaces to procure desirable lake ores, by reason of the absorption of these mines by the trusts, compels the smaller furnaces to depend greatly upon local ores for their main stay. These latter ores are so high in objectionable impurities that they make the iron (being used in such a branch as the malleable, where every impurity is under suspicion) a quite undesirable factor in burden. There is no bad or worthless pig iron. There is a method of using it all, irrespective of its inferior quality. We all recognize how hopeless it is with present constructions to eliminate sulphur and phosphorus. There seems no escape from the metalloids. And it is also recognized that great benefits physically would result with their absence. The silicon and manganese are distinctly controllable, or ought to be, with good judgment. As in the instance of silver and gold, we do not wish for a pure iron; that would be a weak affair, and so, therefore, a reasonable amount of alloy of the right kind is desirable. There will be many objections raised with the withdrawal of phosphorus as detracting from fluidity, but all these seeming stumbling blocks will be readily overcome with careful experimnet. With a prepared lining and the employment of a flux this anticipated furnace will revolutionize malleable methods. There is no doubt that the annealing will be shortened in no small manner. The writer places great confi-

dence in the idea that this proposed melting hearth will be modeled after the Siemens-Martin. Producer gas is so readily controlled and heat conditions so uniformly alike that here, as nowhere else, seems the possible outcome of the new furnace. This new idea iron should show a tensile development of 42,000 pounds, with an elongation averaging 6 per cent. in 6 inches. The unquestioned feature of uniformity will commend itself at first glance, knowing, as we do, the difficulty experienced in present furnaces to produce succeeding heats like former ones. The feasibility of the basic open hearth to handle malleable is not doubted. I has been melted successfully in the acid open hearth and the basic is but a step further on. The field, now debarred, which the introduction of the proposed furnace would open is as large as that attending the development of radical changes in other branches of the art. Irons which are now distinctly off grade could be reclaimed and put into market on a par with those of known higher gradings. Foundry irons with phosphorus at 2 per cent. and over could be worked without any trouble whatever. No matter how high the percentage of impurities may be the metallic iron is as pure in a foundry iron as the highest grade Bessemer open hearth pig irons, for if the impurities are removed the resultant metal cannot but be good. The possibilities of this proposed furnace for handling malleable are as yet to be developed. There will be some opposition to overcome by projectors, but the end is assured as certain. It should commend itself to careful managements as a great step onward toward the betterment of a now sometimes uncertain quantity.

In referring to Mr. Wheeler's article, printed above, Benj. Talbot says in the issue of Nov. 16:

In E. C. Wheeler's excellent article on the "Physical Characteristics of Malleable Cast Iron," I notice he refers to the use of a basic lined furnace for refining the iron and states that the time in now ripe for some such improvement in this branch of the iron trade. It may interest him and possibly other malleable

iron casting manufcturers to know what has already been tried in this line.

In 1891 the writer put a basic lining in the air furnace of the Chattanooga Malleable Iron Works and ran it for some time. This was done so that Southern coke irons, which contained too much silicon and phosphorus for the ordinary acid hearth, could be used. Excellent malleable iron castings were obtained, but the fact was developed that the ordinary air furnace was not suitable for a basic lining made of shrunk dolomite, if it was to be chilled off every day after tapping.

The metal changed and became refined more rapidly on the basic than on the acid hearth. In fact, with heats of 8 or 10 tons run through a small tap hole and caught in hand ladles, as now practiced, the last half of the metal would be refined too much and become too sluggish to pour the castings successfully. This difficulty was encountered with 6 tons of metal and led the writer to suggest that steel works practice be adopted, so that the metal could be tapped rapidly through a large hole into a ladle. This was done and the metal was successfully repoured from the storage ladle into the small hand ladles and from them into the molds.

A few years later a basic lining was put into Stanley G. Flagg's foundry in Philadelphia, and the experiment tried here again indicated tht it would be necessary to abandon the present system of hand ladles used in emptying the furnace and substitute a large ladle, so that the metal could be run from the furnace rapidly. It is possible that with the basic material now available better results (as regards the wearing of the hearth) may be obtained with the present crude and extravagant form of furnace, but in the writer's opinion a gas furnace with air regeneration will prove to be a great economy, although much more expensive to build.

If large malleable iron casting manufacturers desire to reduce the cost of their present method and are not afraid of the necessary capital expenditure, they have only to consult the people interested and study the process now used in a large basic steel

works to find out that a process and furnace is already developed which is eminently suitable for their trade. This process is a continuous one and requires a tilting furnace to obtain the best results. Liquid metal is also required if a large output is desired from one furnace, so that in the absence of suitable liquid blast furnace metal a cupola would be necessary to melt the pig iron. The method of operation is as follows: A tilting furnace of about 15 tons' capacity when filled would be installed. In this furnace a heat of 10 tons would be refined to the desired point necessary to make the castings. Instead of pouring this out into the ladle 5 tons—preferably of liquid metal—would be added to the refined liquid metal in the bath. The silicon in the added metal ought to be at least twice as much as the refined metal in the bath. The result would be that the impurities in the 5 tons would be immediately reduced by mixture alone, and the action of the oxide of iron in the slag would rapidly bring the silicon and carbon of the entire bath down again to the point required for good castings. As soon as this condition was obtained the furnace would be tilted and 5 tons poured out and the operation just described again repeated. Slag would be flowed away from the furnace through the slag spout as often as desired and slag forming additions would be added when necessary.

A furnace working under such conditions, if charged with liquid metal instead of solid, would make 5 tons of refined metal in about one hour. It could be purified in much less time, but the question of the necessary degree of fluidity must be considered and can only be ascertained by actual practice. If the added liquid metal contained considerable silicon it would add heat to the bath by its oxidation. This would mean an output of some 35 to 40 tons of refined metal in a shift and would necessitate continual pouring into the molds all through the day. The furnace would also have to be kept hot and charged with solid stock during the night, so that the bath would be ready to receive the liquid metal for the next day's work. A furnace of larger or smaller capacity would of course increase or decrease the output in the same ratio.

I notice that it is suggested in Mr. Wheeler's article that any class of pig iron could be used with the basic lining, even if it contained 2 per cent. phosphorus. I am afraid that this is an erroneous conclusion, as my experience with the basic process proves that such metal could not be used to any extent in the mixture for malleable casting purposes. Iron containing 2 per cent. phosphorus is used in the basic open hearth steel process, but the phosphorus is only entirely eliminated where the metal has passed the refined cast iron stage and become steel. Phosphorus and carbon are expelled together in a basic furnace when covered with a suitable liquid basic slag.

A basic lining will enlarge the sources of supply of pig iron for the malleable casting trade, as the phosphorus and sulphur can be reduced, which is exactly the opposite to what is occurring in the present practice. In other words, phosphorus constantly increases in the acid hearth from the waste of iron due to the remelting and oxidation from the air blast. This is rectified by using pig iron containing less phosphorus than the sprues and defective castings remelted.

The writer believes that the value of the basic lining to the malleable casting trade will be in the use of coke irons of more or less irregular silicon contents and with less than 0.30 phosphorus and doing away with charcoal iron entirely, unless this competes with the other in price.

Whatever the future may bring forth, Mr. Wheeler will be found to be correct in his advocation of a basic lined gas furnace as being the next step forward in his trade.

AMERICAN MACHINIST.

In the issue of Nov. 2 R. H. Palmer illustrates the molding of a large spur-pinion.

Joseph Horner contributes an article to the issues of Nov. 16 and 23 entitled "Making Revolving Crane Beds."

THE TRADESMAN.

Referring to the scarcity of soft irons and the annoyances arising therefrom, E. H. Putnam says:

When certain light castings that have to be tooled run a little too hard, and you increase the per cent. of No. 2 soft in the mixture, with the result that the castings come still harder, and the more you "soften" the harder the casting product, till at last you modify the difficulty by reducing the per cent of softener (?) and increasing scrap and No. 2 foundry, you are apt to suspect that the furnace has treated you as a belated guest, and your suspicions are very probably correct, too. When the hotels are all overcrowded the belated guest is fain to sleep in a cot bed in the hallway. He may kick more or less, but he'll take that cot bed just the same. And the landlord knows it too! he'll smile and smile and—take your half dollar. He knows, of course, just what a bed ought to be, and just what kind of room it ought to be set up in. But the demand for the normal conditions exceeds the supply, and the guest may take what's left or camp out. And that is what is the matter with the iron market. Less than two years ago, a certain blast furnace company voluntarily sent us the analysis of a carload of iron, just shipped, and suggested the furnishing of analysis with each carload. Of course we gladly accepted this proposition. But a good many furnaces at the present time are very quiet on this point. Indeed, judging from results, I am inclined to think that grading by fracture is much more common in practice at the blast furnace now than it has been for several years past. In grading by fracture it sometimes happens hat No. 3 foundry is taken for No. 2 soft, and vice versa. Both of these irons have a comparatively fine grain in the fracture, and they look much alike, especially to the untrained eye.

It is well known that before chemistry was much employed for the determination of grade, certain knowing ones made a pretty bunch of money by their knowledge of the fact that a high silicon iron was often shipped as No. 3 foundry. And just now, some people are suffering because No. 3 iron is sometimes

shipped for high silicon. It is simply one of the inconveniences of prosperity. But do not jump to the conclusion that you can cure the difficulty by employing a chemist at the foundry. A chemist can tell you what the iron is. Of course he can tell the per cent. of the carbon, silican, sulphur, etc., but you already know all you need to know about that; you know the iron is not what you want, and neither you nor your chemist can make it what you want. Your chemist could analyze the iron, and so, demonstrate to the blast furnaceman of whom you bought it that it is not what you called for. But the blast furnaceman knows that well enough already. When you report to him the character of the product, he knows just what you need, and he will furnish what you want if possible, and if not, why, you must take what you can get; and probably you'll be mighty glad to get it, too. Of course I do not mean to suggest any abatement of effort in the direction of perfection in product; but when you do not get what you call for in pig iron now-a-days, just remember that "there are others."

Writing of "Cores and Core Mixtures," the same author says:

So long as a patent core compound is advertised for sale upon the market, it may safely be assumed that there are many foundries where they do not know how to make cores, and they either do not try to learn, or else do not know how to learn how. Some people would think it a bold assertion to say that the practice of measuring the ingredients of the core mixture does not prevail in half the foundries of the country. Yet I am of opinion that this would be within the truth, and if so, what wonder that there is trouble with the cores in many foundries? Open your watch at the back and observe the graduated scale under the steel pointer, with the letter F above, at the left, and the letter S at the right. Of course you know that if you move the pointer toward the F the watch will gain time, and if you move it toward the S it will run slower. But if your watch does not run correctly, how much must the pointer be moved in order to regulate it properly? You can't answer the question, and neither can

anybody else. You will observe that the graduations consist of long and short lines in alternation. Now, if the watch loses five minutes a day, it might be well to move the pointer to the second long mark toward F. Now, if twenty-four hours later, you have forgotten how far the pointer was moved, you will have made absolutely no progress toward regulating your watch, unless it happen (which is not at all likely) that the first move was just what was required. Assuming that the watch now gains a minute a day, the pointer may be moved back toward S by the distance of say one mark. Having kept a record of what has been done, twenty-four hours hence by a very slight movement of the pointer you will probably be able to set the pointer so as to "regulate" the watch accurately. In these operations you have simply moved the regulator, toward or from a certain point measuring and remeasuring the distance of each movement. You see the measuring of the distance expedites matters greatly, for without that it might take ten times as long, and in the meantime the chronometer would be giving poor service. Now, iron founding may appropriately be compared to the operation of regulating a watch. No watchmaker can make a watch run accurately without going through a process similar to the above. It is guess work, based upon judgment of long experience, but after a few attempts the record of measured movements gives him the data that will enable him to act with precision.

Assuming that you use sand and flour for a core mixture, if you have never measured accurately the ingredients you do not know in what proportions they should be used. In this case, one man's rule is of little use to another. Both the sand and the flour vary greatly in consistency, therefore each man must originate his own rules; and how can this be done except by measurement? The next time one of your molders loses a half days work from blown cores, just go and ask the coremaker what proportion of sand and flour he uses. He will probably answer: "One to ten." As this is about right, you think, you excogitate for the cause of the trouble in some other direction. But wait a bit; ask him how he measures the sand.

"With a wheelbarrow!"

"And how do you measure the flour?"

"With a shovel!"

"And do you think you get an accurate measurement in that way?"

"Always have!"

Ah! yes; he always has indeed, except when he has not, and that is when the castings blowed from the cores. It seems like a superfluity to insist to the foundryman that the sand and flour for the core mixture must be measured with accuracy in order to succeed; but it is nevertheless warranted by the fact that not one-half of the foundrymen follow the practice, and by the further fact that patent core compound finds a large sale in foundries that would not need it if they but knew how to use flour and would always act up to their knowledge.

THE FOUNDRY.

Eli H. Pearce illustrates some examples of skimming gates.

The Poole Molding Machine is described in the November issue.

The foundries of South Africa are dealt with in a contribution by James Cherrie. We take the following extracts therefrom:

"Cape Town has no works of any consequence. The five foundries put together would not make a decent shop. The principal work is in connection with buildings or in small repair work for steamers calling there. The custom of the shops is to fill the floors up and then put on the blast. The one I worked in, if they cast twice a week they were doing well. The shops are built with no regard for comfort or convenience, and have nothing to work with. If you can make your work all right and make plenty of it you may get along. I don't think any molder there cares whether he gets along or not, as there is no incentive to work. Wages are from $1.50 to $2.50 per day. Living is dear and very inferior. Six dollars per week is about the cheapest for board. Most of the boarding houses are on the hospital system, with cots for each boarder and only space left for a few

chairs, and the owners are inclined to be a little independent. With three or four steamers calling each week, coming and going, there are always plenty of boarders.

"There are four foundries in Johannesburg, the Old Rand, the Austral, the Clyde and the Vulcan, employing in all about one hundred molders in busy times. The foundrymen have not as yet seen the necessity of looking at the foundry as a place requiring light or ventilation, except in the Vulcan, and it seems wonderful that this place is doing so well. The Old Rand foundry is a curiosity, their two cupolas looking like huge beer bottles. The shop is built of corrugated iron, the daylight entering through each end of the shop. They have a small hand traveling crane, the posts that hold it up being a little shaky, and are only held in position with rope, and yet this shop casts pieces weighing as much as three tons. Their drying stove or core oven is out of doors, being a trench in the ground with a fire in one end and an old water pipe at the other for a chimney. The oven roof is made of loose sheets of corrugated iron, yet in spite of these apparent drawbacks and lack of appliances, this shop does the best business in the town, and the molders don't get time to get tired of one thing, as work is continually changing.

"Needless to say, one can see strange ways of working here. Gear wheels, pipes and pulleys make up the principal work. Pattern wood is very expensive, as it all comes from Sweden, and in order to economize in this item they have got into the habit of using sweeps and core boxes. I don't think there is a gear wheel pattern over three feet in diameter in the town, all others being made in cores. All of this, however, is their business, and molders should not complain, although where wheels are to be made very often a pattern would be of better advantage. Pipes are made from skeleton patterns and copes fitted for the work are not provided, instead all molds are made with flat copes and sunk partings. The cores are generally made from a sand core box, the plan adopted is to level a bed and use a templet and sweep, to make the core of the proper shape. A heavy core arbor is made and put in the shape and sand built up high enough to sweep up the top of the core from the same templet. After

the core is swept up the core box is dug away, and the core lifted on stools and finished.

"The molding sand is very poor and nearly every mold for castings weighing more than one hundred pounds has to be wet-blacked and skin dried, and when this is done it is like so much dust. One has to exercise extreme patience in setting the cores in a pipe mold. When you see your two-days' work in the cleaning shop you are ashamed, although you have worked the very best you know how. When there are six or eight pipes on the floor getting skin dried with soft coal for fuel and no ventilation to carry off the smoke, one begins to feel sorry he learned the trade. In some small castings where the molds are not dried, you will find it difficult to produce clean castings. No matter how well you may have finished your mold, you will find on looking at your casting that where you expected sharp corners is a lot of loose sand and a general ragged appearance all over. The reason is that after you have closed up your work the industrious ant has been helping you. These insects are the plague of Africa to both farmer and molder and are in all new sands used in the foundries.

"The heaviest castings made in Johannesburg are gear wheels of about six tons weight for the gold mines. But it is not for want of good molders that heavier work is not accomplished here, as you will find as good men there as anywhere else. It is cheaper to send to England for heavy castings if the time can be spared to wait for the shipment. Pig iron and coke have to be imported and duty is charged at 12½ to 15 per cent, bringing the price of iron to over $50 per ton. There is a Transvaal make of coke considerably cheaper than the imported article, but the first order is generally the last, as you have to drop the bottom before the shop is all cast. The Vulcan foundry—Thos. Begbie & Co., Ltd.—have built a large new foundry, and likely in the near future the others will have to look to improvements and facilities for doing work cheaper. It was my pleasure to occasionally go into this shop and note the improvements and better conditions under which the men work, which includes plenty of light and room, and everything to work with in abundance. They

have a ten-ton traveling crane and in a short time they are going to change it to electric power. Their machine shop is newly fitted with electric power, and the foundry is next in order for the change. A short time ago they put in a gear molding machine, the first in Africa. This foundry is in charge of Mr. Rowe, an Australian, a practical, up-to-date mechanic, and one that has an eye to the interests of the firm and the comforts of the molders as well. With the exception of the Old Rand Foundry, the other shops use an English patent cupola, with large receivers for collecting the metal. There is a cupola in a neighboring state put up on the ideas of the general manager, the heaviest casting they have made weighing a little over a ton. The improvements he has devised consists in the tuyere pipes being located sixty inches above the bed. The foreman wanted to change the design, but could not convince the manager where the change would be of any advantage.

"Molders' wages in Johannesburg are $5 per day, and in some cases more, the hours of labor being fifty-one hours per week. Work is unsteady. A breakdown at some of the mines may keep a shop busy for a few days, when men are hired to get it out fast, and then they are laid off. It is generally night and day until a breakdown job is finished. Overtime is paid for at the rate of time and a half, with double time for Sunday work. I am sorry to say that Johannesburg is troubled with a good many molders who have a bad thirst, and when trade is at its best the trouble gets to be a real affliction.

"The laboring work is done by the native Kaffir races, and here one meets with more trials until he acquires some knowledge of the native's language. In my opinion all that can be said in the native's favor is that he is cheap. Some are good workers and the majority of them can riddle sand and carry iron, outside of that they are of little account. The native is paid at the rate of $15 per month and gets his food, which is a porridge made of mealy meal (mealy meal is sweet corn ground). Sometimes he gets a change of diet when the corn is boiled whole. He is happy and contented, has neither toothache or headache; he is very saving in his habits and looks forward to the time when he

can go home to his kraal and purchase one or more wives to do the farming work. His stupidity is sometimes amusing, as is shown, when six or eight are carrying up iron and scrap to the cupola, each with a sack of it on his back, some going up, others coming down; should they meet on the middle of the stairs they will stop and debate as to who has the right of way."

Charles Butterfield, in "A Cupola Chat," writes as follows.

"There is nothing more aggravating than to have to run a long heat in a small cupola. Most founders seem to overlook the fact that even if it is possible to keep a cupola in operation for several hours, it is not by any means economy to do so.

"In the first place, no molder can work with any satisfaction to himself once the wind is put on. Whenever he is forced to do so the result is as unsatisfactory to his employer. It is always a good thing to have a cupola too large. It is easy enough to make it smaller, while it cannot be enlarged beyond a certain size.

"In the second place, aside from the loss to the employer in the length of time the molders must wait for the heat to be completed, there is another distinct disadvantage which I doubt but few foundries take into consideration when they install a small cupola.

"As is well known, a cupola becomes clogged after a certain length of time. The lining burns out and adds a certain amount of slag to that made by the ash of the fuel and the impurities of the iron. What we term the burning of the lining is accomplished when the heat reaches such a degree that it melts the fire brick. It does not take much figuring to prove that the longer a cupola is kept in blast, the hotter the fire brick becomes and the quicker are they worn or melted away. In other words, there is a greater wear and tear on a cupola lining by keeping it in blast three hours continuously than by melting three heats of one hour's duration each. It is a common experience that cupolas will melt satisfactorily for the first hour, this is more especially the case with those of smaller diameter, but afterwards the iron will lose the sharpness it had at the start.

"A double lining is always to be preferred, because a lining

will burn out a certain amount anyhow, and with little care retain this position when once found. This it cannot be permitted to do with a single lining, because the hollow at the melting point would leave too little protection for the shell."

Ezra Estep illustrates how mechanical facilities will improve the product of the foundry and at the same time reduce its cost.

In "Cast Iron Notes" W. J. Keep answers an inquiry concerning "the analysis of a good composition for fine gray iron (soft and strong) castings, also a list of desirable irons" as follows:

If there was a given composition of cast iron that would give the best results in making gray iron castings, it would cause the pig irons entering into such composition to be in such demand that the price would advance beyond the reach of most, and would make miserable the lives of those who could not get them.

Fortunately, there will never be any such corner on any brands of pig iron. The founder will always be able to use the irons that are cheapest in his own market. The reason for this is that various compositions will produce exactly as good results as others, and that any composition can be varied by each founder to suit his individual purpose. Once in a while a chemist used to say that he could formulate a chemical composition that would produce the best gray iron castings for a given purpose. Rarely two chemists will agree as to what such composition should be, for each man has had experience with a composition that suited his purpose, and because, as I have just said, various compositions will produce exactly as good results. Evidently the propounder of this question makes castings light in weight as well as in quantity. Any founder or any chemist who is familiar with this class of castings could name a composition that would make satisfactory castings, but another equally as good a composition might be more convenient in a different locality.

Suppose that I should say that carbon should be as high as 3.50 per cent with 3.10 graphite and 0.40 combined, but how is a founder going to know whether the iron that he can purchase contains this proportion? As there is no practical way for him to find out it is to be hoped that this will not affect his success as

a founder. As a matter of fact, good dark gray pig will generally contain enough carbon and near enough in the right proportions. If the grain is uniform in size and open, it shows that the furnace was working well.

My advice to every founder is not to worry about the exact percentage of carbon but be guided by the appearance of the fracture of the pig. If the grain is close or irregular the founder should be careful until he finds whether this appearance shows that the iron needs some addition to make it suit his purpose. Once in a while an iron that has an open even dark grain may not make satisfactory castings, but farther on I will show how all such variations can be adjusted.

Suppose that I should say that phosphorus should be as high as 0.75 and no higher than 1.00 per cent, how can a founder find any exact percentage? Phosphorus somewhat prolongs the fluidity of melted iron, and gives a molder a chance to get hot iron into his mold, and 1.00 per cent will not weaken castings.

In most parts of the country pig irons will not contain this much and it is not necessary to search for irons containing more.

This means, don't think much about it. What about sulphur? Chemists and almost all say, now look out for this. However, you will not find it in good looking pig iron and you can purchase fuel that does not contain an excess of it. If you make light castings and have considerable remelt, sulphur in the casting will work up to 0.05 and sometimes as high as 0.07. Can you help it? If you cannot prevent it there is no use in worrying over it. I would rather not have it get into the castings and I do not know as sulphur does any good. All you can do is to be reasonably careful in the purchase of fuel.

You won't find much manganese in the pig iron; by much I mean over .75 per cent, and 0.50 will be nearer the average. You will never know that you have this amount in your castings. It is no trouble to keep manganese below 1.00 per cent, and in most cases you couldn't get it higher if you wanted to; so there is not much use to think about manganese. If you did know what percentage was best for your use there is no practical way for a founder to find the exact percentage of phosphorus, sulphur or

manganese, either in the pig iron that he uses or in the castings that he makes.

If the man that you buy iron from is honest he will tell you what to expect. There is only one more thing in pig iron and that is silicon. I will not treat this as I have the other elements that are found in cast iron, because the presence of silicon turns combined carbon, the chief hardening element, into graphite, which is always in soft iron. Sulphur increases combined carbon and in that way hardens cast iron, but silicon by changing it back to graphite counteracts any evil influence of sulphur. Many conditions attending foundry operations increase the combined carbon, but silicon remedies the trouble.

If you ask me to give a definite percentage of silicon for any kind of castings, I must tell you that the amount needed depends upon how much influence of these foundry conditions, how much sulphur in the fuel, and how much combined carbon in the pig iron, has to be counteracted. I have said that it is not practicable for the founder to find the amount of these things to be counteracted and he cannot, therefore, tell exactly how much silicon to provide, but he must have enough and a little more will do no harm.

Now I am going to say over the thing that I always say, that the only practical way for a founder to put the correct amount of silicon in his casting is to measure the shrinkage of a test bar of any size he chooses to make, but he must always use one size. The shrinkage is increased by too little carbon, by combined carbon, by sulphur, by manganese and by many foundry conditions, and such shrinkage is decreased by an increase of silicon. Therefore, by trial find out what the shrinkage of your test bar is at ta time when the quality of your iron is satisfactory, and call that your standard.

If the shrinkage increases, increase your silicon. To increase it you must know from the one you purchase it from, which pig iron contains most silicon, and then increase that iron. This iron very often has considerable phosphorus, but not enough to do any harm. This is all the chemistry that any founder needs to enable him to make good castings. In this way he can use

any gray iron that is cheapest in his market, or can use scrap in almost any quantity.

The name of an iron is not of much importance, but the price and the way to make good castings out of it. I have told you this.

A chemist might try to give a formula for a good iron for soft gray castings, and might give a good one, but it would be the result of some analysis that he had made of a good casting, which would be the correct way, but just as good a casting could be made with very widely varied proportions, and when conditions varied it would be necessary to vary the proportions of silicon.

If you want to try this, take a casting that is satisfactory in every way and ask some chemist to tell you what that casting contains, and then have it analyzed and see how different it will be.

At one time I submitted a casting that had 30 per cent greater strength than would naturally be expected, and asked for a formula of its composition, and did not find any one willing to venture an opinion, and when I gave the analysis the composition was very far from that which would have been considered theoretically best, but the silicon was there to counteract all defects.

Writing of "The Gas Engine in the Foundry," Geo. A. True says:

It is somewhat surprising that, in considering the various powers which can be applied to foundry use, the gas engine has not received more attention. It is probably due to the fact that mechanical people, as a rule, are less familiar with the advantages of this power than are the manufacturers who are not in the machine trade, or in any other strictly mechanical line of business.

For a number of years, this type of engine has been steadily growing in favor with manufacturers of clothing, with printers, farmers, millers, elevator men, and in various kindred lines, but it does not seem to have made much headway, until recently, in foundries or machine shops. In fact, the mechanical world does

not seem as well acquainted with the practical use of this power as does the farming community. One reason for this is probably that in foundries and machine shops the use of steam in some form is more or less necessary, and the managers have figured that if an engineer is necessary to keep steam on the boiler, they might as well use a steam engine. In some locations this may be a good reason; in others, it is not.

The past ten years has witnessed the introduction of thousands of electric motors in iron manufacturing plants in small units, driving isolated machines. There can be no question of the value of electric power in a great many cases for such duties, but there are many locations where a gas engine could be applied to similar service and where the actual cost of operating with a gas engine would not exceed 50 per cent of the cost of operating by any other means.

Within the past month the trade journals have published notices of the installation of several gas engines by one large Eastern malleable iron plant. The foundry is especially a place to which the gas engine can be readily applied. As a rule, the groups of machines are widely separated as to location. The blower and tumbling barrels are very often located at extreme opposite ends of the shop. Very often it is necessary to operate the elevator at a time when no other power is required. Again, it is convenient to operate tumbling barrels when no power is required for elevator or blower. In such situations the gas engine can be readily adopted. It is not dependent upon a central power station. It is an entirely independent prime motor, can be instantly started and stopped, and the consumption of fuel goes on only while the engine is operating. This is not strictly true of any other system. All other methods of power distribution are dependent upon a central power station. The gas engine is a unique factor as a prime motor.

But the greatest commercial value of the gas engine lies in the small cost of the fuel it consumes. In using the term "gas engine," we refer to the engine using either natural or artificial gas, or to the gasoline engine, which, as a rule, can be used with gas by making a slight change in the valve mechanism. Many

engines now on the market can be changed from gas to gasoline instantly while running. It is common to speak of the cost of fuel consumption in these engines as about one cent per H. P. per hour. It will average less than this. In some of our large cities, where cheap natural gas is used, it will not exceed four tenths of a cent per H. P. per hour. A two-H. P. gas motor, the fuel cost of which is eight cents a day, ought to be an interesting factor in power production.

In addition to the economy resulting from the low cost of fuel, the fact that a gas engine does not require a licensed engineer, and that any machinist of fair ability can look after it, and keep it in good running order in connection with his other duties, makes it a very desirable motor for shops where machinists or mechanical men are employed. There has been a great deal of talk about gas engines being unsatisfactory on account of frequent repairs and the inability of the purchaser to keep them in good running order. In about 90 per cent of these cases the trouble can be traced, not to the engine, but to the fact that the proper kind of a man is not looking after it. The very fact that farmers, bakers, butchers, etc., have used so many of these engines, gives a hint of the cause of complaint. These people, as a rule, are totally unacquainted with mechanical details of any kind, and when a battery runs out, or any little detail about the engine gets out of order, they are unable to understand it, and become discouraged, without making any effort to remedy the defect. This is not true of a machinist or a mechanical man, because, with a very small expenditure of time, he can find the difficulty and remedy it. There is no reason why a few extra wearing parts should not be constantly kept in stock. They cost less than one month's fuel-saving usually.

In one large plant now being installed in a Pittsburg foundry, several large gas engines are being used to drive generators developing electricity, which is carried to electric motors running groups of tools throughout the plant. This is another admirable application of the gas engine, as it enables the manufacturer to produce his electric power at about one-half the cost of its production by steam, and this is a matter which ought to make the

gas engine a welcome competitor, even to the electric motor manufacturers. In this case instead of being a rival of electricity, it is an aid, by becoming a prime generator of electric current.

The subject is a broad one, and cannot be covered in a short talk, but it is one worthy of study by those who are wrestling with the subject of a cheap and safe power.

There are undoubtedly a great many situations where steam and electricity are expressly indicated, but there are also many power conditions which call especially for the gas engine, and it will be surprising if there is not a larger demand for it among foundries, steel plants and machine shops in the future.